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THE USE OF COPPER SULPHATE IN WATER FILTRATION.

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An experiment was begun at the Lawrence Experiment Station, during 1904, in order to test the value of copper sulphate as an aid in the purification of polluted water. In this investigation a a large experimental filter, 17 feet 4 inches in diameter and containing two and one-half feet in depth of good filter sand, was used. Before the beginning of the copper sulphate experiment, this filter had been in use for 11 years, filtering Merrimac River water. Beginning May 17, 1904, however, copper sulphate was added to the raw water applied to this filter, the amount used at first being one part of the sulphate in 1,000,000 parts of water, and the greatest amount used during the year of experiment being one part in 133,000 parts of water.

The copper sulphate was applied directly to the water upon the surface of the filter, but the volume of water always above the sand allowed a storage of water, after introduction of the sulphate, ranging from five and one-quarter hours to slightly more than eight hours, varying, of course, with the rate of filtration at which the filter was being worked.

Examination of the sand of the filter from time to time, during the experiment and after the experiment had ended, showed the accumulation of a large amonnt of copper in the sand, and also showed that the copper penetrated throughout the entire depth of the filter. At the end of the experiment, the amount of copper in the surface sand of the filter was 22.8 parts per 100,000; at a depth of 12 inches, 7.6 parts per 100,000; and at a depth of 24 inches, 6.8 parts per 100,000. Giving these results in terms of copper sulphate, the surface sand contained 89.5 parts of copper sulphate per 100,000; at a depth of 12 inches, 79.8 parts; and at a depth of 24 inches, 26.6 parts.

Anlayses of the effluent of the filter showed that this effluent contained copper, calculated as copper sulphate, varying in amounts at different times from 1.2 parts per million parts of water to 5.8 parts per million parts of water. At the end of August, 1905, three months after we had ceased to add copper sulphate to the applied water, the effluent contained copper, calculated as copper sulphate, to the amount of 3.7 parts per million parts of water, showing that copper was continually being taken into solution from the deposit within the filter.

The actual volume of water passed through this filter daily varied from 14,000 to 26,000 gallons, and the rate of filtration varied from 2,800,000 gallons per acre daily to 5,200,000 per acre daily.

In connection with this work, experiments were made in regard to the rate of sedimentation of copper sulphate after being mixed with water in large tanks at the experiment station, using, of course, water of the same character as that used in the filtration experiment. In one of these sedimentation experiments it was found that there was practically no sedimentation of the copper until after a period of 20 days; in one, a sedimentation of 50 per cent in 54 days; in one, a sedimentation of about 60 per cent in 62 days; and in one, a sedimentation of 58 per cent in 21 days. No sedimentation occurred in periods of 24 or 48 hours.

If, therefore, in this filtration experiment, a sedimentation tank had been placed between the point of application of the copper sulphate and the filter, a normal period of sedimentation would have effected little copper removal, and practically all the copper not passing through the filter and appearing in the effluent would have collected upon the filtering material.

During the active period of this investigation, samples of the water passing to the filter and the effluent of the filter were taken daily for bacterial examination. The bacterial results obtained from the filter during this experiment, when compared with those obtained during the year previous to the application of copper sulphate to the raw water, show no gain in bacterial removal on account of the use of the copper sulphate—rather the reverse. During the year previous to the use of copper sulphate, the raw water contained 8,300 bacteria per c.c. and the effluent, 73 bacteria per c.c.—or a bacterial efficiency of 99.12 per cent. During the year of copper sulphate treatment, the raw water contained 7.400 bacteria per c.c., and the effluent of the filter, 114 per c.c —a bacterial efficiency of 98.5 per cent, 0.62 of 1 per cent less than during the previous year. During both years practically every cubic centimeter sample of the raw water that was tested contained B. coli. The effluent of the filter during the year before the copper treatment contained B. coli in 13.5 per cent of the cubic centimeter samples examined, and during the year of copper treatment it was found in 26 per cent of the cubic centimeter samples examined.

Summarizing, it can be said that poorer results in water filtration were obtained when using copper sulphate than when operating the same filter without the use of the copper sulphate; a poorer effluent, organically, was obtained, and there was an accumulation of copper upon the sand in the filter that would eventually—if copper, in the form in which it remains upon the sand, has any strength at all as a bactericide—reduce the efficiency of the filter very greatly; that is, the biological actions upon which good results with slow sand filters depend would be badly impaired.